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# Technical News Bulletin



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## NATIONAL BUREAU OF STANDARDS Technical News Bulletin

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology
- Center for Radiation Research
- Center for Computer Sciences and Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of NBS.

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# THE U.S. METRIC STUDY\*

CONGRESSIONAL DEBATE leading to the passage of Public Law 90-472, the Metric Study Act, represented a far more practical understanding of the nature of the metric problem than was reflected in the turbulence of earlier congressional debates on this subject. Congress did not request a plan for conversion to metric usage or even pose the question of conversion. Instead they asked the Department of Commerce to examine the impact on the United States of current trends and possible courses of action. Thus the Congress has asked us to attempt a thorough and rational analysis of the impact on the United States of present world trends with respect to measurement language. We are not to accept the goal of metrication as an act of faith, nor are we to reject it as an alien influence in our culture. We approach this very complex subject with open minds, determined to attempt what no other nation has yet achieved, a comprehensive and rational evaluation of the nation's alternative courses of action.

Let me make clear that I am talking about the International System (SI) adopted by the General Conference of Weights and Measures. This Conference is an international treaty

\*The National Bureau of Standards is conducting a congressionally authorized three-year study of the impact of increasing worldwide usage of SI units on this country. The study is under the direction of Daniel V. De Simone of NBS. As part of this study a series of Conferences is being held to solicit the views of various sectors of the society. At the first of these Conferences, sponsored jointly by NBS and the Engineering Research Foundation, NBS Director Lewis M. Branscomb presented the opening address, a condensed version of which appears here.

organization to which the United States and the governments of 42 other nations formally adhere.

All modern industrial nations assure the compatibility of their scientific measurement systems, at the highest levels of precision, through SI measurement standards and their intercomparison. To this extent the United States has been metric for nearly a hundred years. The measurement standards maintained at the National Bureau of Standards are all SI standards. The customary or pound-yard-second system standards are exactly defined by a specified numerical ratio to the fundamental SI standards. And an act of Congress, passed in 1866, made metric units legal in commerce and for other uses.

The metrication issue consists of both software and hardware questions. These must be carefully distinguished, because the advantages and costs associated with changing software and hardware are so different. For example, in this country a very large fraction of consumer goods is now sold in prepackaged form with weights and measures established at the factory and printed on the package. For these products a change to metric language is a software change, quite different from the hardware change required when materials are served in bulk and the measuring instrument must be at each retail outlet.

This study is being conducted in a dynamic environment. The British program of metrication has gone into high gear, Australia has made a determination to convert to metric

usage over a ten-year period, and the Canadian Government has issued a white paper declaring "eventual conversion as a definite objective of Canadian policy." Thus, it is a reasonable premise for our study that if the U.S. retains its customary measurement system, the U.S. will eventually be the only major nation in the world using this system.

The last few years have also seen major changes in the activity of international engineering standards organizations. Both the International Organization for Standardization (ISO) and the International Electro-technical Commission (IEC) have established a policy strongly recommending maximum use of SI units in the writing of international standards.

Perhaps more significant than the growth of standards writing activity is the development of new means for standards enforcement that may make international standards compliance involuntary, at least in certain markets. For example, the Economic Commission for Europe, in February 1970, endorsed a recommendation that standards used in international trade should be harmonized on the basis of ISO and IEC recommendations. Industrial standards can be generated and enforced in such a way either to facilitate trade within a group of cooperative nations or to erect a barrier against imports of nonconforming products.

I do not wish to imply, at this stage, that a broad effort to harmonize our national standards with those of other nations would help or hinder the

U.S. self-interest in the short term. This depends rather strongly on our trade policy, and may vary sharply from one industry to another. But I do want to emphasize that should international standards harmonization be our objective, we can pursue this objective by more aggressive participation in international standards activities, *whether or not* we adopt the metric measurement language for domestic use. U.S. companies that would like to have their products compatible with international engineering standards may be perfectly willing to have them described in metric language in return for having U.S. technology and industrial practice written into the standard.

The rapid growth of numerically controlled machines offers the possibility of mixed production of objects designed in metric and customary units, fabricated on the same machine subject to control by properly translated programs. We hope that our study will identify and document the changed circumstances that, if extrapolated some years into the future, will give us a picture of the environment within which a future metric conversion might take place. Similarly, there may be other effects, such as a high degree of interlocking of many industries dependent upon the same set of standardized components and materials, that make conversion increasingly difficult. We must try to measure not only the present circumstances with respect to metric usage but the way these circumstances are changing with time.

### Degrees of Usage

We do not believe that instantaneous mandatory conversion is a policy alternative that requires serious study. Instead, it is likely that if the U.S. decides to go metric it will be done through a coordinated national program based on the voluntary cooperation of all sectors of the society. The ways in which these sectors could respond to such a rational program might be called accommodation, adaptation, or conversion, each rep-

resenting an increasing degree of effect.

*Accommodation* represents a minimal response: changing no measuring equipment but using mental conversion or conversion tables in order to translate one measurement language to another.

*Adaptation* means the use of dual labeling and dual dimensioning without changing sizes.

*Conversion* is the most comprehensive response. In this case the U.S. would change not only its measurement language but also many designs and practices. These designs and practices would be changed only as necessary to produce a reasonable degree of harmony with other metric nations and to permit metric units to become the customary measurement language for Americans.

In a surprising number of areas the process of conversion has actually taken place. The pharmaceutical industry is substantially converted to metric usage and the ball bearing industry is rapidly in the process of the same transition. Coal mine safety regulations are expressed in metric dimensions (so many milligrams of dust per cubic meter of air), and swimming pools are commonly built to an integral number of meters in length.

The most important problem facing industry is to identify just those hardware changes that would in fact be needed or advantageous if there is a national consensus to convert.

### Alternative Time Scales

There are obviously alternative time scales for adapting or converting to metric usage. We assume that if the nation decides to change its common usage measurement system, there is an optimum period over which to achieve that change. If this premise is correct, it follows that to accelerate the change at a more rapid than optimum pace or to delay it unnecessarily would be relatively more costly than an optimum rate of change.

Excluding instantaneous change as unrealistic, we are examining alterna-

tives with respect to time scales. First, it might prove wisest national policy for the Government merely to continue to observe the scene, increased metric usage resulting wherever an individual or company finds it advantageous. A second alternative is for the Government to lead in the adoption of a national policy with respect to adaptation or conversion and to coordinate such a change on a national level.

Two time scales are being examined. First we are asking what would be the impact of a national program of conversion designed to be completed over a ten year period. Ten years has been selected arbitrarily, but is the period accepted by the British and Australians as the appropriate time table for this process.

We would also like to estimate what an optimal time frame might be, should the preponderance of the evidence suggest that planned conversion be the national policy. Since many sectors of the economy are deeply interlocked with respect to materials, components and software, and each may find a different time scale to be a suboptimization of the total economy, this is a difficult problem to solve. Accordingly, we are asking each affected sector of the economy to tell us what would be the "optimum" time scale for it to convert, on the assumption that other sectors of the economy have made the necessary changes to permit orderly conversion by the respondent. Since we are seeking quantitative cost information from manufacturers with respect to conversion under these two assumptions, we hope it will be possible to make at least a qualitative judgment about the relative merits and costs of different rates of conversion.

### Data Gathering

We are now in the middle of a massive data gathering effort. Fourteen separate studies are underway. Important among them are a set of conferences, questionnaires and inter-

*Continued on p. 270*



# HIGH-SPEED OPTICAL PYROMETER DEVELOPED

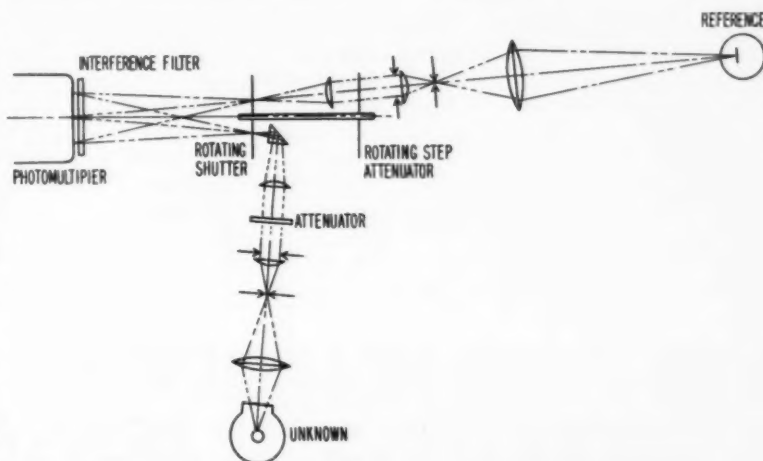
A HIGH-SPEED OPTICAL PYROMETER has been developed<sup>1</sup> by G. M. Foley,\* Leeds and Northrup Company (North Wales, Pa.) in a joint project with the Bureau. The research model pyrometer, along with data acquisition apparatus, is being used at NBS to make high-speed, high-temperature measurements of the thermophysical properties of refractory metals. [See the following article, High-Speed Measurement of Thermophysical Properties at High Temperatures, p. 254.] The instrument, at a rate exceeding 1000 per second, compares an unknown to a reference source with an accuracy that ranges from 1 K at 1335 K to 2.8 K at 2700 K. Its precision [standard deviation] at 2000 K ranges from 0.2 K for a response time of 0.8 millisecond to 0.01 K for a response time of 1 second or longer. The variation in response time is obtained by averaging successive values; at 1 second its accuracy and precision are as good as or better than those of any other pyrometer of the same speed.

Optical pyrometry is the most accurate noncontact means known for temperature measurements of opaque objects in the range above 1000 K. The conventional visual and photoelectrical pyrometers, however, are usually capable, at best, of response times of 1 second. The need of an accurate pyrometer with faster response time arose in a project to measure the thermophysical properties of refractory metals by pulse methods.<sup>2</sup>

The high-speed pyrometer is designed so that a phototube is alternately exposed to light from an unknown source and a calibrated reference lamp. The exposure to each

source is of the same duration, approximately 0.2 millisecond, and the exposures are uniformly spaced in time. An amplifier, integrator, and an analog-digital converter are used to evaluate each exposure of the unknown with respect to a member of a "staircase" of reference exposures.

The reference staircase is obtained by means of a metal attenuator disk that has three pairs of sectors around its circumference. One pair of sectors is cut away, so that light is unobstructed. The second pair is perforated in a pattern of small square holes, so as to transmit less than 50 percent of the light that falls on the sectors. A third pair, similarly perforated with smaller holes, transmits less than 25 percent of the light. Thus, as the disk rotates, the reference illumination changes in three steps during each half revolution.



Optical system employed in the high-speed pyrometer developed jointly by Leeds and Northrup Co. and NBS. By alternately sampling 208 microsecond pulses of radiation from an unknown and a reference source, the pyrometer is capable of making over 1000 temperature measurements per second.



a- SEQUENCE OF PHOTOCATHODE ILLUMINATION



b- SEQUENCE OF INTEGRATOR VOLTAGE

The sequence of photocathode illuminations and integrator voltages shows the cycle of operation of the high-speed optical pyrometer. Unknown pulses (X) are interlaced with a staircase of reference pulses (R).

\*Mr. Foley was a Guest Worker at NBS during a portion of this work.

A shutter disk with six large, equally spaced apertures, and the attenuator disk, are both rotated at 200 rps by a synchronous motor. As the disks are rotated, the shutter disk opens the reference light path for 208 microseconds, after which it closes for 208 microseconds. The unknown light path is then opened for 208 microseconds, after which it closes for 208 microseconds. The reference path is then opened and the cycle repeated. The reference pulses form two staircases per revolution, which are interlaced with the unknown pulses. The shutter disk also has a smaller circle of timing apertures, which generate pulses to control the electrical system.

The electron multiplier phototube is an end-on type, mounted so as to reduce microphonism and to minimize the influence of magnetic fields, which are strong around the high-current circuits often used for heating specimens in fast experiments.

The pyrometer is connected to an analog-digital converter and to a small general-purpose computer for real-time processing of the data. When processing begins, the computer waits for a single half-revolution of the pyrometer shutter. During this period the integrator voltages resulting from three exposures to the unknown sources, and those resulting from a full staircase of exposures to the reference sources have been stored in the computer memory. An equation for determining the temperature is then solved twice for each voltage resulting from the unknown exposure, first by comparison with the reference step that was less than the unknown, and then with the reference step that was higher than the unknown. The two results are then averaged.

The computer is capable of completing the calculation for all three unknown exposures before the shutter disk has completed an additional one-

third revolution. Whenever a new exposure occurs, the calculation is interrupted briefly to store the resulting integrator voltage. More than one-third of the computer time is free to be used for further processing of the temperature data, or for processing of other data gathered in the experiment.

This real time processing is valuable because the integrator voltages resulting from several successive revolutions of the sampling disk can be averaged, and advantage taken of the greater precision that results. Operated in this manner, the pyrometer is a general purpose instrument with a response time that can be adjusted to any value longer than 0.8 millisecond.

<sup>1</sup> Foley, G. M., High-speed optical pyrometer, *Rev. Sci. Instr.* **41**, 827 (1970).

<sup>2</sup> Cezairliyan, A., Morse, M. S., Berman, H. A., and Beckett, C. W., High-speed (subsecond) measurement of heat capacity, electrical resistivity, and thermal radiation properties of molybdenum in the range 1900 to 2800 K, *J. Res. Nat. Bur. Stand. (U.S.)*, **74A** (Phys. and Chem.), No. 1, 65 (Jan.-Feb. 1970).

## HIGH-SPEED MEASUREMENT OF THERMOPHYSICAL PROPERTIES AT HIGH TEMPERATURES

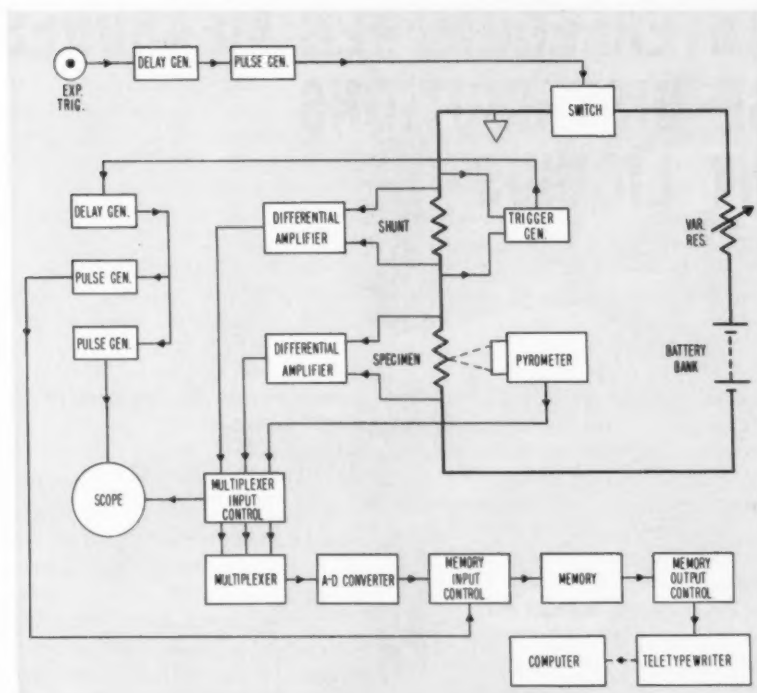
MANY PROBLEMS EXIST in conventional methods of measuring specific heat, electrical resistivity, and various other thermophysical properties at high temperatures (above 2000 K). The problems arise from a specimen's exposure to high temperatures for relatively long periods of time, resulting in heat loss, chemical reactions, evaporation, diffusion, loss of mechanical strength, etc. As a result, the applicability of conventional methods to measurements of properties at high temperatures has been limited and a high-speed method that permits heating and measurement of pertinent quantities in a very short time has been needed.

Recently A. Cezairliyan, M. S. Morse, and C. W. Beckett of NBS developed a technique to measure thermophysical properties of electrical conductors at high temperatures with millisecond resolution.<sup>1</sup> Measurements of heat capacity, electrical resistivity, and hemispherical total and normal spectral emittance at 2000 K are obtained as accurately as with conventional methods; above 2500 K the method yields accuracy that surpasses conventional methods. Another distinct advantage of the technique is that it allows the measurement of several properties simultaneously. The high-speed measurement system of millisecond resolution is expected to

play an important role in high-temperature research on refractory metals and their alloys, as well as other high-melting point electrically conducting substances.

The high-speed method developed at NBS is based upon rapid heating of the specimen by a single pulse (subsecond duration) of direct current. Specific heat and electrical resistivity are calculated from data obtained during the pulse heating period.

Because of the short duration of the experiment, the only significant heat loss from the specimen is that due to thermal radiation. Data taken during the initial free cooling period following the heating period permits the



High-speed system for measuring specific heat, electrical resistivity, melting point, and thermal radiation properties of electrical conductors at temperatures above 2000 K.

computation of hemispherical total emittance and application of a correction to specific heat for the radiation heat loss. From separate pulse experiments, in which radiation from the surface of the specimen is measured in addition to its temperature, normal spectral emittance is obtained.

The system consists of an electric power pulsing circuit and associated high-speed measuring circuits. The pulsing circuit includes the specimen in series with a 28 V battery bank, a variable resistance, a standard resistance (shunt), and a fast-acting switch. The high-speed measuring circuits include detectors, an analog-to-digital converter, a core memory, and associated equipment.

The specimen used in the pulse experiments is a tube approximately 100 mm long, 0.5 mm in thickness, and outside diameter of 6.3 mm. A small rectangular hole in the tube wall approximates blackbody conditions for optical temperature measurements.

Spring-loaded knife edges are used as potential probes. The specimen chamber is designed for conducting experiments either in vacuum or a controlled atmosphere.

The specimen temperature during an experiment is measured by means of a high-speed photoelectric pyrometer, which permits 1200 evaluations of the specimen temperature per second.<sup>2</sup> [See the preceding article, High-Speed Optical Pyrometer Developed, page 253.]

A high-speed digital data acquisition system has been designed and constructed to meet the special requirements of the experiments. The system consists of a multiplexer, analog-to-digital converter, and a core memory together with control and interfacing equipment. Thus, the system eliminates the use of relatively inaccurate oscilloscopic recording techniques. During a dynamic experiment of subsecond duration, the signals are brought to the multiplexer and then to

the analog-to-digital converter. The digitized output is stored in a core memory having a capacity of over 2000 words of sixteen bits each. After the experiment is completed, information stored in the core memory may be retrieved in the form of numeric printing and punched paper tape using a teletypewriter. Since the laboratory has access to a time-sharing computer, the memory may be unloaded directly to the computer. The high-speed digital data acquisition system has a full-scale signal resolution of approximately one part in 8000 and a time resolution of 0.4 ms.

The apparatus has been used to measure thermophysical properties of molybdenum from 1900 to 2800 K. The imprecisions of specific heat and electrical resistivity measurements were 0.6 and 0.08 percent, respectively. Analysis of sources and magnitudes of errors provided an estimate for total inaccuracy of 2 to 3 percent for specific heat and 0.5 percent for electrical resistivity in this temperature range.

<sup>1</sup> Cezairliyan, A., Morse, M. S., Berman, H. A., and Beckett, C. W., High-speed (subsecond) measurement of heat capacity, electrical resistivity, and thermal radiation properties of molybdenum in the range 1900 to 2800 K, *J. Res. Nat. Bur. Stand. (U.S.)*, **74A**, No. 1, 65 (Jan.-Feb. 1970).

<sup>2</sup> Foley, G. M., High-speed optical pyrometer, *Rev. Sci. Instr.* **41**, 827 (1970).



A. Cezairliyan calibrates the pyrometer used in high-speed thermodynamic measurements.

# HOLOGRAPHIC INTERFEROMETER MEASURES ABSORBED DOSE DISTRIBUTIONS IN TRANSPARENT LIQUIDS

A POPULAR NEW TOOL for radiation research is the high-current, pulsed electron machine that produces intense bursts of radiation. NBS has recently acquired two machines of this type which produce maximum electron energies of 2 and 0.6 MeV respectively and which may be used in various program areas involving high-intensity radiation, plasma physics, medical diagnosis, radiation processing of materials, and radiation chemistry. A holographic technique was developed<sup>1</sup> at the Bureau to measure the absorbed dose distribution resulting from single pulses of electron radiation produced by these machines.

<sup>\*</sup>Dr. Hussmann has been at NBS on a NATO Fellowship from the Federal Republic of Germany.

Eckart K. Hussmann\* of the NBS Center for Radiation Research developed the technique with support from the Division of Isotopes Development of the U.S. Atomic Energy Commission.

The technique employs holographic interferometric recording of changes in the refractive index of a liquid due to the temperature rise produced by the absorption of electrons. Previous measuring techniques used temperature sensors placed inside an absorber. The disadvantages of sensors are that they can disturb the radiation field, and they also provide relatively poor spatial resolution of the dose distribution. With the new method developed at NBS, the radiation field is not disturbed by a probe, resulting in

a considerable improvement in the spatial resolution.

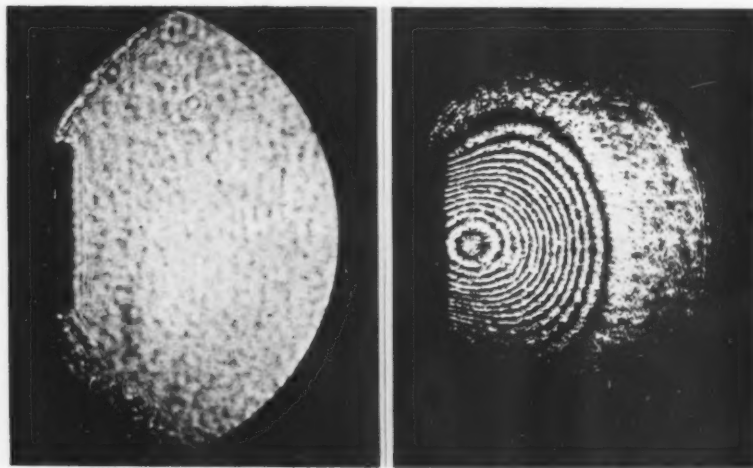
## Measurement Technique

The apparatus used to measure and record the temperature distribution of a high-intensity, pulsed electron beam includes a low-power (0.1–1.0 mW) helium-neon laser; a cell containing a transparent liquid; photographic plates; and various lenses and mirrors to establish the desired light paths.

When the liquid is irradiated, the deposited energy raises the temperature ( $T$ ) of the liquid ( $\Delta T$  may range from 1 to approximately 10 °C), producing measurable changes in the refractive index. Local changes in the refractive index are determined by means of holographic interferometry.

The transparent absorbing liquid is held in an aluminum cell with fused silica windows on both sides. A parallel wavefront of laser light traverses the unirradiated liquid and is recorded on a hologram. Then a high-intensity pulse of electrons is fired into the cell, through a thin aluminum window, perpendicular to the optical path. The electron beam triggers a second laser exposure about 15 milliseconds later. This wavefront passes through the now irradiated liquid and is recorded on the same holographic plate.

Reconstruction of the object beam is carried out by developing the hologram, returning it to its original position, and illuminating it with only



At left, the shadowgram of an unirradiated liquid; at right, a holographically generated interferogram representing the absorbed dose distribution of 35 kV electron pulses.





*Eckart K. Hussman sets up the holographic interferometer for measuring the absorbed dose distribution from radiation beams supplied by such high-current, pulsed machines as this domed instrument.*

the reference beam, thus producing a fringe pattern generated by the interference between the two wavefronts passing through the unirradiated cell and the irradiated cell. These patterns are representative of the temperature distribution in the liquid produced by an electron pulse of about 30 nanoseconds duration.

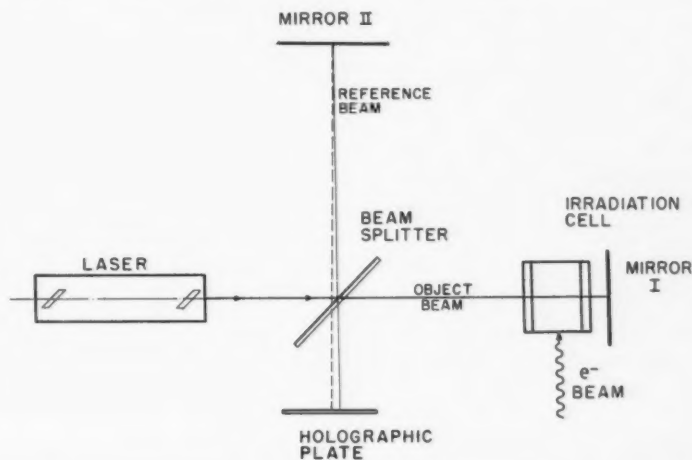
The three-dimensional dose distribution can be computed from the interference pattern, provided the following conditions are fulfilled: (1) the dose distribution is essentially symmetrical to the direction of propagation of the radiation beam, (2) the dose is high enough to produce a sufficient number of fringes, and (3) the refractive index of the homogeneous liquid is known as a function of temperature.

This technique can be extended to measure the temperature distributions produced by high-intensity gamma, neutron, or microwave radiation. Present investigations success-

fully used distilled water as the absorbing liquid for electrons. Future studies are planned to expand the types of transparent liquids that might be used. These investigations will study the influences of the atomic

number and thermal conductivity of the liquid on the absorbed dose distribution.

<sup>1</sup> For further details, see Hussmann, E. K., A holographic interferometer for measuring radiation energy deposition profiles in transparent liquids, *Applied Optics*, in press.



*Simplified diagram of holographic interferometer.*

# HIGH PERFORMANCE AC-DC CONVERTER

## Circuit Useful in Measuring Average AC Values

AN ACCURATE ELECTRICAL CALIBRATION DEVICE—an average ac-to-dc converter—has been developed by two staff members of the Bureau to meet a recently recognized need. Louis A. Marzetta, of the Institute for Applied Technology, and Donald R. Flach, of the Institute for Basic Standards, used operational amplifiers in a rectifier-and-filter configuration characterized by superior accuracy and stability.<sup>1</sup> The converter will be used for comparisons and calibrations, where the rectified average value of the alternating current or voltage is of interest, by measuring its direct current output with a voltmeter or potentiometer. It can also be related to precise r.m.s. (root-mean-square) measurements of the highly sinusoidal outputs of today's sine-wave generators.

### Alternating-Current Measurements

The effects of alternating current can be best expressed in most cases as the power transferred to the using circuit, which is proportional to the square of the instantaneous voltage. The voltage used in calculations is the r.m.s. voltage. For this reason much emphasis has been placed on developing devices that read r.m.s. voltage and current precisely,<sup>2</sup> although most ac digital voltmeters—which are now in wide use—continue to be average-responding.

With the recent availability of stable sources of sine-wave power of low distortion and high stability, the unique position of r.m.s. values has changed. With such sources ac-dc transfer work in the laboratory can be done as well with average-reading as with r.m.s.-reading instruments. The wider use to which high-quality

average-reading instruments, such as digital voltmeters, can be put increases the need for a standard for average transfer.

Mr. Marzetta built the ac-dc converter around a modular-type, laboratory-quality operational amplifier in a dual half-wave rectifying circuit. Resistances in the feedback loops set the stage amplification. The filter's dc output can be used to drive a dc digital voltmeter or it can be measured by nulling against a potentiometer.

Most applications require use of a high-impedance input to the device. This is obtained by preceding the rectifier with a high input-impedance, unity-gain operational amplifier.

Care must be taken in selecting components for the converter; some of the

resistors must be of precision types. Differential operational amplifiers using field-effect transistors have been found to be satisfactory.

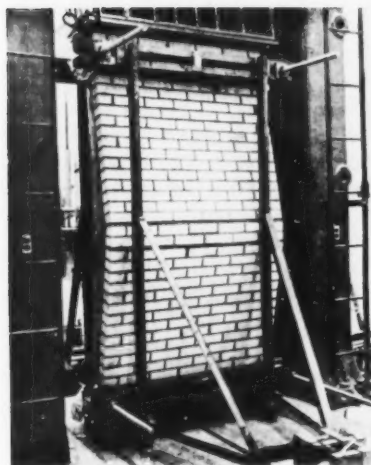
The new converter can be operated at frequencies from dc to 100 kHz, with a precision of 200 ppm for frequencies up to 20 kHz. The accuracy of the rectifier-filter portion of the circuitry (excluding the high input-impedance stage) can be 20 ppm for frequencies from dc to 1 kHz. Present work is directed at converters of even more accuracy for use over a greater frequency range.

<sup>1</sup> Marzetta, L. A., and Flach, D. R., Design features of a precision ac-dc converter, *J. Res. Nat. Bur. Stand. (U.S.)*, 73C (Engr. and Instr.), Nos. 3 and 4, 47-55 (July-Dec. 1969).

<sup>2</sup> Peak ac, dc voltage comparator, *NBS Tech. News Bull.* 51, No. 1, 15 (Jan. 1967).



Donald Flach inserts a modular operational amplifier into a precision average ac-dc converter that he helped design. Conversions can be performed with a precision of 200 ppm at frequencies below 20 kHz.



*Typical failure of a brick wall loaded with a vertical compressive load.*



*Data from prism specimens tested to failure, such as these, are used to predict the performance of similar wall sections.*

TO DETERMINE THE PREDICTABILITY of masonry wall performance, the Institute for Applied Technology has obtained data on the flexural strength of masonry walls of various types of construction, subjected simultaneously to transverse and vertical loads. In this work, by F. Y. Yokel, R. G. Mathey, and R. D. Dikkers, over 100 walls of various types of masonry construction were tested. The data were then used as a basis for the development of analytical procedures to predict the strength of masonry walls subjected to combined compressive and transverse loads. The application of this approach should lead to new design procedures, similar to those used for steel and soon to be adopted for reinforced concrete.

## TRANSVERSE STRENGTH OF MASONRY WALLS

The specimens used in the NBS tests were hollow and solid 8-in concrete block walls, 4-in brick walls, 8-in composite walls of concrete block and brick, and cavity walls. The two types of cavity walls tested consisted of two 4-in block walls (wythes) with a 2-in cavity between them, and 4-in block and 4-in brick wythes with a 2-in cavity. The wythes in the cavity walls were connected by means of steel ties. Various types of mortars were used. All materials used in the wall panel construction were available commercially and were representative of those commonly used in building construction.

Eight or more wall panel specimens of each of the 10 wall types were tested by applying uniform transverse loads, uniform axial compressive loads, or a combination of both types of loading. The wall specimens were nominally 4-ft wide and 8-ft high.

The transverse load was applied uniformly by an air bag made of 20-mil polyvinyl sheeting, which covered the entire wall. A steel reaction frame provided support for the air bag on one side of the wall specimen. On the opposite side of the wall, upper and lower horizontal reaction bars were spaced 82.5-in apart, and attached to another reaction frame.

Compression testing consisted of applying a load through the head of a 600 000 lb-capacity hydraulic testing machine. The load was applied at a rate of 60 000 lb per minute up to failure or to a load level that was maintained while the transverse load was applied. Two wall specimens of each type were axially loaded to compressive failure with no transverse loading. Deflections were measured by transformer type displacement transducers. Vertical and horizontal applied loads, as well as lateral deflec-

tions of the wall specimens, were recorded digitally on paper tape by an automatic electronic multichannel data logging system.

Small prism specimens of each type of wall construction also were prepared to determine the properties of the various types of masonry. Compression tests were conducted on 2-, 3-, and 5-block-high prisms and on 5-brick-high prisms. Flexural tests were carried out on 2-block-high and 7-course brick prisms.

It was found that the transverse strength of masonry walls can be reasonably predicted by evaluating the cross-sectional capacities on the basis of prism tests and reducing that capacity for slenderness effects by accounting for the added moment caused by wall deflection. Cross-sectional moment capacity of wall panels was conservatively predicted by a theoretical interaction curve based on compressive prism strength and linear strain gradients.

The qualitative observation was made that at large eccentricities the flexural compressive strength of masonry exceeds the compressive strength developed in pure one-dimensional compression by a significant margin, and that flexural compressive strength increases with increasing strain gradients.

The transverse strength of cavity walls was conservatively predicted by assuming that each front and rear wythe of the wall carries its proportional share of vertical loads, and that transverse loads, but not shear forces parallel to the plane of the wall, are transmitted by the steel ties connecting the front and rear wythes. The transverse strength of composite brick and block walls was approximately predicted by assuming that the walls act monolithically.

# NBS PROPOSES NEW COLOR MATCH CLASSIFICATIONS AND INDEXES

I. NIMEROFF OF THE INSTITUTE FOR APPLIED TECHNOLOGY has devised a new classification scheme for color matches based on the parameters—source, object, observer—that vary.<sup>1</sup> In addition to the classification scheme, indexes to characterize spectral differences for all possible classes of color matches have been developed.

Color and color matching play an important role in the production and distribution of goods in our economy. Paints, dyes, inks, and cosmetics obviously must be produced to meet rigorous color specifications. The manufacturers of automobiles, household appliances, office equipment, light bulbs, apparel, and many other products must pay careful attention to color and color matching. Sales of petroleum products on the basis of color matching amount to millions of dollars each day. It is important, therefore, to completely characterize spectral differences in color matches whether they arise from the specimen, illuminating source, or the observer.

Since color is defined in terms of the spectral characteristics of the ob-

server, source, and specimen, seven different classes of color matches are possible. These arise from taking one, two, or all three of the parameters variable at a time. Presently, one of these matches is designated spectral, three are designated metameric,\* and three have no designations.

There is an increasing need for standard procedures by which to assess the nature of these color matches. To meet this need the new scheme was developed, based on the variable parameter or parameters; that is, those matches in which one parameter varies would be designated observer-variable, source-variable, or specimen-variable; those in which two parameters vary would be called source-specimen-variable, source-observer-variable, or specimen-observer-variable matches; if all three vary, the match would be a source-specimen-observer-variable match.

Indexes to characterize the spectral differences of color matches presently have several applications. For

\*Metamerism is presently defined as a color match obtained by an observer in spite of spectral differences.

example, a color match for a given sample of unknown pigment may be obtained under one set of illuminating and viewing conditions, for example, north skylight. If the color match is achieved by a different colorant formulation, the match is not spectral and the colors differ when observed under another set of illuminating and viewing conditions, for example, daylight fluorescent lamplight. This situation is currently designated as specimen metamerism and indexes are used to quantitatively specify the spectral differences of metameric pairs.

Another use of metamerism indexes is the source-specimen index used with tristimulus colorimeters, wherein combinations of three primary-source irradiances are selected to match a given color. This index, devised at NBS,<sup>2</sup> gives a quantitative measure of spectral differences in color matches obtained by trained observers.

The present work is a generalization of the metamerism index developed for tristimulus colorimeters. The indexes resulting from this generalization have a high degree of correlation with the few indexes already in use. In addition, indexes for all the other color match classes are now possible. Applications of these indexes may be very important, in terms of commercial problems, because of the involvement of groups of observers.

<sup>1</sup>For further details, see Nimeroff, I., Color match classification by variable parameters, *J. Opt. Soc. Am.* 59, No. 11, 1533 (Nov. 1969).

<sup>2</sup>Nimeroff, I., and Yurow, J. A., Degree of metamerism, *J. Opt. Soc. Am.* 55, 185 (1965).

## National Technical Information Service Established

On September 15, 1970, the Bureau's Clearinghouse for Federal Scientific and Technical Information was transferred to the newly formed National Technical Information Service (NTIS), and its functions merged with a broader mission for NTIS. NTIS is a primary operating unit of the Department of Commerce.

NTIS is a major step towards consolidating and improving the collection and distribution to the general public of much of the scientific and technical information, as well as business and economic information, produced at Federal expense. The NTIS will enlarge considerably the

range of services presently available through the Clearinghouse and will seek to increase the use of its publications. Each year, nearly 50 000 titles are added to this collection, and more than two million copies of reports are sold; these figures are expected to grow substantially under the new effort.

Secretary of Commerce Maurice H. Stans has appointed Peter F. Urbach as Deputy Director of the National Technical Information Service and designated him to serve as Acting Director. Mr. Urbach was Deputy Director of the Clearinghouse in 1967-68.





The NOAA Ship *Oceanographer*.

## CONCENTRATION OF OXYGEN IN THE ATMOSPHERE

CONCERN THAT THE OXYGEN CONTENT of the earth's atmosphere may already have been significantly reduced by some types of pollution appears unfounded according to the results of a joint study by the National Bureau of Standards and the National Oceanic and Atmospheric Administration. Data collected and analyzed by E. E. Hughes of NBS and L. Machta of NOAA show the oxygen abundance in clean air during 1967-70 to be statistically the same as all reliable measurements reported since 1910.<sup>1</sup> Pollution of the oceans by herbicides and insecticides, particularly at the continental shelves, raised fears that one of the earth's major sources of oxygen replenishment, phytoplankton, would be affected. The consumption of oxygen through the burning of fossil fuels was also feared.

At the time of the NBS-NOAA undertaking in 1967, few reliable measurements were available to establish an environmental trend toward the reduction of oxygen in the atmosphere. Only five measurements or series of measurements had been made of the oxygen abundance between 1910 and 1967. Present indications for the trend in oxygen degradation, then, are made from a comparison of these and the 1967-70 data.

For this investigation, an improved method for measuring the oxygen content of air within 0.01 mole percent or better was developed at the Bureau. With this degree of accuracy, the abundance of oxygen relative to the total of oxygen, nitrogen, argon, and carbon dioxide in the air can be measured with some certainty in the third decimal. The Bureau method, based on a technique that utilizes the paramagnetic properties of oxygen, is free from dependence on elaborate equipment, highly skilled operators, and time-consuming operations.

Samples of atmospheric air were obtained by NOAA and the National Science Foundation during cruises of the research vessels NOAA Ship *Oceanographer* and National Science Foundation's *Eltanin*. To determine possible variations in oxygen content in the atmosphere in areas of differing oxygen producing capacity, samples were taken over the continental shelf and in mid ocean. A second group of samples was collected by Mr. Hughes at a relatively isolated rural site in western Maryland.

These samples, 88 in all, were analyzed for oxygen content by comparison with NBS Standard Reference Material No. 1609, a standard air of certified oxygen content. Each

one-liter sample was divided into three portions, and at least ten measurements made on each. The average for the oceanographic analyses is 20.946 mole percent oxygen in dry air with a standard deviation of  $\pm 0.0017$  mole percent, and the average value for the rural site samples is  $20.946 \pm 0.0018$  mole percent. (The standard deviations are derived from the mean values of the three portions of each sample.) By comparison, all reliable oxygen data since 1910 fall in the range of 20.945 to 20.952 mole percent, showing either a very small or zero change in atmospheric oxygen since that year.

Failure to detect changes in atmospheric oxygen indicates that there may now be less cause for alarm about the reduction in photosynthetic production of oxygen than was previously supposed. However, future combustion of all known, recoverable fossil fuels could lower the oxygen content to about 20.8 mole percent. The direct effects of this lower value on human respiration would be insignificant since the change in oxygen partial pressure is equivalent to a rise of only about 75 meters in altitude.

<sup>1</sup> Machta, L., and Hughes, E. E., Atmospheric oxygen in 1967-70, *Science* 168, No. 3939, 1582-1584 (June 1970).

# MICROFILM READER-RAPID COPIER

NBS Develops Device for  
National Library of Medicine



*Instrumentmaker Charles Summers positions the light filter of the partially assembled microfilm reader-copier. When the copy sequence is triggered, the microfilm and the diazo film (reels at bottom and right) are pressed together between two glass plates and the filter is raised to permit ultraviolet light to expose the diazo film.*

A MICROFILM READER-COPIER, developed by the Bureau for the National Library of Medicine, provides a rapid means of automatically making original-size prints of frames selected from rolls of microfilm. The Select-a-Frame machine was designed by James Strohlein and Thomas Bagg, of the Bureau's Center for Computer Sciences and Technology, and was fabricated by Charles Summers, of the Bureau staff.<sup>1</sup> Its performance at the Library indicates that such a machine would be useful to other libraries to fill requests for "hard" copy of selected portions of their microfilm.

## Using Microfilm

In 1968, it is estimated, tens of billions of 16-mm and 35-mm microfilm frames were exposed and tens of millions of enlarged copies made from microfilms for users in industry, business, education, and government. Reasons for its widespread use are that the microfilm copy is more permanent than most papers currently used and can be stored in a fraction of the space required for the original documents. Further, requests for printed material can be met by making copies from microfilm without loaning a publication; users never find that the book they want is out on loan, overdue, lost, or mutilated.

Some users have their own viewing equipment for film copies, while others require full-sized paper copies. Making page size copies from the microfilm of successive pages—as of a book—is no problem, but finding and copying only certain frames on a reel of microfilm is tedious, time-consuming, and costly. The alternative—printing some or all of entire reels and manually extracting the desired prints—is extravagant, in addition. The Select-a-Frame has features that enable it to satisfactorily meet these criteria: fast, easy, and inexpensive.

## The NBS Reader-Rapid Copier

The design of the NBS copier takes advantage of the efficiency of continuous flow enlargement printing by copying each frame selected on a sec-

ond roll of film and later printing all of this intermediate roll. Diazo film\* was selected for this medium because it is easily processed and can be handled in office light without fogging. Also, it makes possible a novel design feature; because it is transparent and unaffected by visible light, only one optical path is needed and the diazo film can remain in the path during viewing of the microfilm.

The Select-a-Frame copier outwardly resembles other motorized microfilm readers. One-hundred-foot reels or cartridges of 35-mm microfilm can be loaded onto the transport mechanism and moved forward or backward, either rapidly or slowly, by use of a single lever. The light source is a mercury arc lamp mounted in a small housing in front of the operator; optics beyond the film focus the image at approximately document size on a vertical screen at the operator's eye level.

The mercury lamp serves a dual purpose; its visible light is used for viewing and the ultraviolet component for exposing the diazo film. Most of the time the ultraviolet component is absorbed by a filter between the lamp and the film.

The feature that is the key to the Select-a-Frame design philosophy—allowing the diazo film to remain in the optical path—is the mechanism for positioning the filter so that it functions as a shutter for ultraviolet radiation. The filter is pivoted at its top; only when its linkage tilts it up out of the light beam does ultraviolet “light” reach the diazo film to produce a latent image.

## Operation

The operator can move the film rapidly to the approximate location of the first frame he wants and then, with the same lever, move the film slowly

\*This is film coated with a diazo material. The diazo material is decomposed when subjected to ultraviolet radiation. It is developed by being bathed in ammonia vapor; unexposed emulsion becomes opaque while fully exposed material remains transparent. This is a dry process that can be performed with inexpensive equipment.



Having positioned a microfilm frame he wants to copy, James Strohle depresses the COPY button (left) that will expose a 35-mm diazo film to the microfilm image.

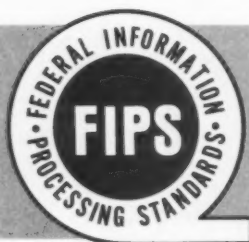
back and forth to position the desired frame in the viewer. When he presses the COPY button two glass plates squeeze together to clamp the microfilm and the diazo film together, emulsion to emulsion. Simultaneously, the filter is flipped up for the preset exposure time (typically 3 seconds) and dropped back into the beam path to end the exposure. Next, the plates separate and the diazo film is automatically advanced one frame. The operator can make additional copies of the same frame by re-pressing the COPY button, or he can position the microfilm to the next frame desired.

The exposed diazo film is run through a processor for development and then fed into a xerographic en-

larger that produces a continuous roll of document-sized paper copies.

Added to the Library's xerographic roll printer system is an automatic cutter through which the strip of paper prints passes. The cutter is triggered by “cut marks” on the prints which originate from a mark on the glass plates that clamp the film in the Select-a-Frame. The Select-a-Frame copier was designed for use with the commercial roll-printing and cutting equipment to form a highly efficient copying system.

<sup>1</sup> Strohle, J. M., and Bragg, T. C., A Selective Roll-to-Roll Printer for Producing Duplicate Microfilm Copies, Nat. Bur. Stand. (U.S.), Tech. Note 516 (Feb. 1970), available as SD Catalog No. C13.46:516 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 25 cents.



# NOTES

## NATIONAL ASSOCIATION FOR STATE INFORMATION SYSTEMS (NASIS)

In March 1969, the Committee on Information Systems of the Council of State Governments met in Washington, D.C., and established a permanent organization of the States to provide for improved management of information systems. Prior to this meeting, the Committee on Information Systems had undertaken several major projects: the development of a model contract for the lease of ADP systems; the development of policy for State Information Systems; the sponsorship of two major reports on data processing in the individual States; participation in the Intergovernmental Task Force on Information Systems; and the sponsorship of a highly successful national conference of executives and legislative personnel interested in information systems.

In view of the Committee's successful accomplishments, a recommendation was made to the Council of State Governments that the Committee's functions be transferred to a larger body. Upon approval, the Committee was redesignated as the National Association for State Information Systems (NASIS), and became an affiliate of the Council of State Governments. The by-laws of the Association provide that:

1. Regular membership will be open to all States and other jurisdictions holding membership on the Council of State Governments.

2. All three branches of government—legislative, executive, and judicial—will be represented.

3. Participation will be encouraged through associate membership and specific invitation of local and Federal officials and other associated groups, including manufacturers and consulting firms.

4. Standing committees will be formed to carry out much of the work of the Association. These committees will be concerned with Federal-State-local liaison, standards, research, education, and interbranch liaison.

The National Bureau of Standards, in promulgating Federal Information Processing Standards, has established contacts with the 50 States through the NASIS. Copies of proposed and approved Federal Standards are provided to the State Coordinators of the NASIS. The State Coordinators can comment on the applicability of these standards within their State and local governments, and consideration is given to these comments before standards are approved for Federal use. Also, the NASIS provides a liaison member to the Federal Information Processing Standards Coordinating and Advisory Committee.

Of particular interest is the work of the NASIS Standards Committee chaired by Donald A. Croteau of New York. The Committee's activities currently lie in three areas: personnel standards, computer acquisition standards, and data standards for information interchange. Requirements for standards in the area of application programming have been recog-

nized, but no work is now being done in this area.

Personnel standards fall into three major areas: job description, examination, and staffing patterns. One of the problems in comparing personnel statistics of various States is that they have organized their staffs differently and use varying job descriptions. The States also have different qualifications and testing procedures for personnel. Standard job titles, experience qualifications, and standard examinations would provide a better basis for improving the information processing staffs of all the States involved.

The Standards Committee is also working towards a standard contract for the procurement of EDP equipment. Also, standard evaluation criteria are needed as a guide to the States for comparing competing proposals.

Data standards for information interchange are also considered as another key standards activity. The Committee serves as the States' liaison activity with the American National Standards Institute Subcommittee X3L8, which is responsible for the voluntary national data standards program leading to standards for representations for data elements. The Committee also has expressed the need for standard formats and data structures to ease and encourage information interchange among state information systems. Data standards needed include: standards for representing States, counties, and cities; standard unique identification codes



for individuals and organizations; a standard geographic locator system; standard representations of calendar dates and time; and standard formats of names of individuals and organizations, including truncating procedures. In this regard, the Committee is providing very close liaison with the activities of the Federal Government and the American National Standards Institute in attempting to achieve compatible standards at the local, State, Federal, and national levels.

The NASIS participated on an Intergovernmental Task Force on Information Systems along with representatives from the Office of Management and Budget, the Advisory Commission on Intergovernmental Relations, the Council of State Governments, the National Association of Counties, the U.S. Conference of Mayors, the National League of Cities, and the International City Managers Association. The Task Force report, dated April 1, 1970, resulted in the following recommendations:

1. Provide for the coordinated development of information systems within each government (local, State, and Federal).
2. Enact the proposed Joint Funding Simplification Act being considered by the Congress.
3. Provide information systems for the president, governors, and chief executives of local governments to facilitate efficient decision making. These information systems would utilize other information systems within the government concerned.
4. Organize active consultation between Federal agencies and State and local governments in the development of intergovernmental information systems in major functional areas.
5. Develop under the leadership of the U.S. Bureau of the Budget\* a standard "package" of socioeconomic data to be used as a base by Federal agencies in obtaining information from State and local governments.

\*Now the Office of Management and Budget.

The same package should be used by State governments in obtaining information from local governments.

6. Create a State-Local Information Advisory Council as a means by which Federal agencies may secure representative views of State and local governments.

7. Create a Local Information Advisory Council within each State to promote effective consultation between the State and local agencies.

8. Require evidence of consultation with State and local agencies (or representative bodies) before approving Federal agency requests for information levied on such agencies.

9. Coordinate and audit periodically the information requirements imposed on other levels of government by Federal and State agencies.

10. Pool the resources of local governments to launch a program of mutual assistance for upgrading local information systems.

11. Enact the Intergovernmental Cooperation Act and the Intergovernmental Manpower Act being considered by Congress.

12. Create an Intergovernmental Information Systems Exchange to: (a) serve as a clearinghouse on information systems that are used or are being developed by local, State, and Federal governments, and (b) promote compatibility among such systems.

13. Establish and operate the Intergovernmental Information Systems Exchange under the auspices of the Advisory Commission on Intergovernmental Relations, assisted by a Steering Committee represented by all governmental levels.

14. Support the Intergovernmental Information Systems Exchange by advanced financial contributions by all levels of government.

15. Accelerate the recently established Federal Government program for the development of standard data elements and codes, particularly in major functional areas. Provide for active and organized consultation with the State and local governments

when such data elements and codes interact with their system.

16. Provide for active participation by State and local governments in the National Program for the Development of Information Processing Standards being conducted under the auspices of the United States of America Standards Institute (now the American National Standards Institute). Such participation would augment and complement the considerable efforts now being devoted to this program by the Federal Government.

17. Implement approved information processing standards at the State and local levels of government, based on the recommendations of the national associations that represent these governments.

18. Designate a Federal Information Center on Assistance Programs to serve as the primary national source of information on these programs.

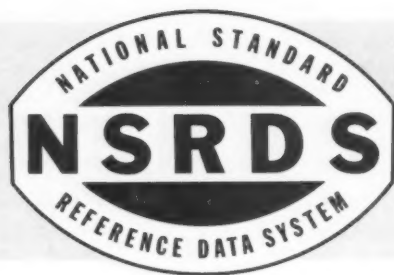
19. Issue guidelines to be used by Federal agencies for cooperating with and assisting State and local governments in improving the flow of information within and among governments.

20. Issue similar guidelines to be used by States and major local governments.

Copies of this report, *Dynamics of Information Flow: A Report by the Intergovernmental Task Force on Information Systems*, may be obtained from the National Technical Information Service (\$3; PB178307).<sup>1</sup>

NASIS holds an annual conference of the various state delegates. To date, conferences have been held in Denver, Colo., and Seattle, Wash. Mr. Carl Vorlander of Wisconsin is the current president of NASIS, Mr. James C. Hughes of Michigan is the past-president and Mr. William C. Walsh of New York is the president-elect. Mr. Robert M. Cornett provides the secretariat to the NASIS from the Council of State Governments, Iron Works Pike, Lexington, Ky. 40505.

<sup>1</sup> Order by PB number for the price indicated from the National Technical Information Service, Springfield, Va. 22151 (formerly the Clearinghouse for Federal Scientific and Technical Information).



# NEWS

*The NSRDS was established to make critically evaluated data in the physical sciences available to science and technology on a national basis. The NSRDS is administered and coordinated by the NBS Office of Standard Reference Data.*

## ION-MOLECULE REACTIONS

The first NSRDS volume in a planned series of critical reviews on atomic and molecular collisional processes has been published by Wiley-Interscience under the sponsorship of the Atomic and Molecular Processes Information Center, Oak Ridge National Laboratory.<sup>1</sup> This planned series of critical reviews is under the general editorship of C. F. Barnett, Director of the Atomic and Molecular Processes Information Center, which has been supported jointly by the NBS Office of Standard Reference Data and the U.S. Atomic Energy Commission.

The study of ion-molecule reactions in gases is a venerable subject, dating back at least as far as J. J. Thomson's early studies of positive rays in his parabola mass spectrograph. Thomson observed "secondary rays," which he attributed to collisional processes. Some collisions produced a fog on the photographic plate in his apparatus; other processes pro-

duced well defined lines. Mass spectrographic studies of ion-molecule reactions early in this century had a profound effect on the development of this area of modern science.

Within the last decade, however, it has become apparent that a deep understanding of ion-molecule reactions is essential to a better comprehension of upper atmospheric phenomena, radiation chemistry, flames, electrical discharges, and many other subjects of fundamental importance. Consequently, a great upsurge of interest in ion-molecule reactions has occurred, and today they are the subject of research in many laboratories. The literature has become extensive, scattered throughout many journals, and badly in need of review. In 1965 the present group of coauthors was coopted by Dr. Barnett with the goal of surveying the subject in a comprehensive manner. This critical review is their product.

The first half of this volume is devoted to a discussion of all the known experimental methods for making quantitative studies of ion-molecule reactions, and a critical analysis is made of the accuracy and reliability of these methods. Considerable space is then devoted to the theoretical foundations of the subject and to the various models that have been adopted

in computations of reaction rates. A review is given of the measurements in the earth's atmosphere from which information on ion-molecule reactions has been deduced, and is followed by a discussion of ion-molecule chemistry. Finally, experimental data on 230 ion-molecule reactions are displayed in tabular and graphical form. All the available data on these reactions were critically analyzed, and the best values were chosen for inclusion. In many cases, in which more than one good measurement appears to have been made on a given reaction, data are presented to indicate the magnitude of the disagreement among the separate results.

Physicists and chemists, experimentalists and theorists, and persons interested in basic aspects of ion-molecule reactions as well as in practical applications will find this book of pertinence and value.

## THERMODYNAMICS OF INCINERATOR PROCESSES

The Office of Standard Reference Data has signed an agreement with the American Society of Mechanical Engineers for the NBS Chemical Thermodynamics Data Center to provide thermodynamic information needed in the design of industrial incinerators for waste disposal.

In the design of incinerators the engineer has two major problems that must be solved in an internally consistent way to obtain satisfactory performance: (a) The composition of the mix of input materials—waste, added fuel, and combustion air or oxygen—must be understood and adjusted so that desired products result from the requisite combustion processes. (b) The heat balance of the process based on energies of combustion (or other reaction) must be known at various stages of the process to maintain proper temperature control. To meet these requirements a substantial body of thermochemical data such as the heats of combustion, heats of formation, heat capacities, and Gibbs energies are needed for the ingredients of waste and their combustion products over a large temperature range.

The monograph material will include tables of thermodynamic and thermochemical data on selected combustible ingredients and their products, discussion and aids for the use of the tables, and an annotated list of other sources of data. Part of the tables will be selected from existing compilations of thermodynamic values, and part will be developed from information contained in the files of the Chemical Thermodynamic Data Center. The work is being done under the general guidance of G. T. Armstrong; the principal investigator is E. S. Domalski.

#### **ACTIVATION ANALYSIS: A BIBLIOGRAPHY**

NBS Technical Note 467, *Activation Analysis: A Bibliography (Part 1, Including Addendum 1—December 1969; Part 2 Revised)*<sup>2</sup> (\$8.50 per set of two volumes, SD Catalog No. C13.46:467), edited by G. J. Boreni, R. S. Maddock, and W. W. Meinke, are two volumes of the second edition of the NBS activation analysis bibliography first published a year ago. Part 1, containing well over 3000 bibliographical entries, each identified by its accession number, remains unchanged; Addendum 1, which has

been added to Part 1, adds just over 1000 new bibliographical entries, similarly identified. The other Volume, Part 2, Revision 1, is an entirely new set of indexes covering all of the entries listed in Part 1 and its Addendum 1. It gives access to the bibliographical entries through four indexes: Author, Element Determined, Matrix Analyzed, and Technique Utilized. Several categories have been added or changed in the revised subject indexes to make them more definitive.

Since the literature on activation analysis—a method of chemical analysis based on detection and measurement of the radiation produced when a sample is bombarded by nuclear projectiles—is continuing its rapid growth, plans to issue further supplements and revisions at appropriate intervals are being made. The basic copy for the bibliography is provided by the print-out of a computer storage and retrieval system into which bibliographic information is being fed as it is received.

#### **LIGHT ELEMENTS IN METALS**

NBS Technical Note 524, *Determination of the Light Elements in Metals: A Bibliography of Activation Analysis Papers*<sup>2</sup> (75 cents, SD Catalog No. C13.46:524), edited by G. J. Lutz, is the second in a series of specialized bibliographies prepared by the Activation Analysis Information Center of the NBS Analytical Chemistry Division. A list of bibliographical descriptions of 240 references is first. This list deals with the application of activation analysis to the determination of light elements in metals, the elements being boron, carbon, nitrogen, oxygen, phosphorus, silicon and sulfur. This list is followed by two indexes arranged according to element determined, subdivided in one index according to the matrix in which the element occurs, and in the other according to the nuclear reactions involved. There is also an author index.

The references included were extracted from the master files of the

Activation Analysis Information Center that is kept up to date on a continuing basis. Publications are indexed in the master files according to the broad categories of Element Determined, Matrix Analyzed, and Technique Used. Currently there are 106 descriptive terms under Matrix Analyzed and 53 under Technique Used. Items for the present bibliography were taken from the category of Elements Determined and from the appropriate keys of Matrix Analyzed dealing with metals. The Center plans to publish revisions of the bibliography geared to the growth of the literature.

#### **ASTM STANDARD METRIC PRACTICE GUIDE**

The American Society for Testing and Materials has issued E380-70, *Standard Metric Practice Guide*, a guide to the use of SI—the International System of Units. This metric practice guide deals with the conversion from one system of units to another of quantities that are in general use and includes the units most frequently used in the various fields of science and industry. The conversion factors given are from the U.S. customary units to those of the International System of Units, which is officially abbreviated as SI in all languages. The guide provides rules for SI style and usage, the rules for conversion and rounding, and includes an appendix on terminology and another on the history of the development of the International System of Units. This guide supersedes NBS Handbook 102 and E380-68 adopted as a standard in 1968. It may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103, for \$1.50.

#### **NUMERICAL DATA ADVISORY BOARD APPOINTS COMMITTEE FOR NATIONAL PROGRAMS**

In 1969 because of the progress in the growth of the National Standard Reference Data System and the emergence of CODATA as an international force, the Office of Critical Tables

was replaced with a new unit, the Numerical Data Advisory Board (NDAB), with Dr. H. van Olphen as Executive Secretary. (See *NSRDS News* in the September 1969 *Technical News Bulletin*.)

The NDAB recently appointed the following members to serve on a Committee for National Programs: J. Ross Macdonald, Chairman (Texas Instruments), W. M. Bright (Warner-Lambert Pharmaceutical Co.), S. P. Clark, Jr. (Yale University), John W. Colman (Westinghouse Electric Corp.), H. C. Gatos (Massachusetts Institute

of Technology), R. M. Hayes (University of California, Los Angeles), G. G. Johnson, Jr. (Pennsylvania State University), W. Klemperer (Harvard University), H. W. Koch (American Institute of Physics), John W. Murdock (Battelle Memorial Institute), R. W. Schmitt (General Electric Co.), W. O. Taff (Esso Research and Engineering Co.), H. I. Fushfeld (Kennecott Copper Corp.), and L. M. Branscomb (NBS), Ex Officio.

These members will help implement the Board's national functions, which

are primarily: (1) To provide counsel on both policy and technical matters for government-sponsored data evaluation and compilation programs under the NSRDS, and (2) To promote private initiative and sponsorship of data programs and to promote coordination of such private programs with NSRDS and other government programs.

<sup>1</sup> Available from Wiley-Interscience, 605 Third Ave., New York, N.Y. 10016, for \$19.95.

<sup>2</sup> Order by SD Catalog Number from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated.

## CONFERENCE *Briefs*

### INTERNATIONAL CONFERENCE ON PRECISION MEASUREMENT AND FUNDAMENTAL CONSTANTS

The quantitative predictions of the basic theories of physics depend on the numerical values of the fundamental constants of nature appearing in the theories. An accurate knowledge of these values is essential if scientists hope to achieve an accurate quantitative description of the physical universe. But more important, the careful study of the numerical values of the constants, as determined from various experiments, can in turn test the overall consistency and correctness of the basic theories of physics. Thus, the objective of the International Conference on Precision Measurement and Fundamental Constants, held August 3-7, 1970, at NBS was to discuss modern techniques of precision physical measurement and their application, along with modern theo-

retical developments, to the determination of the fundamental constants. Although many conferences have been held to discuss either constants or measuring techniques, this was the first conference to collectively organize the groups engaged in these problems.

J. Terrien, Director of the International Bureau of Weights and Measures in France (the international headquarters for standards work), presided at the opening session that included a keynote address by the General Chairman of the Conference, Lewis M. Branscomb, NBS Director. Dr. Branscomb described the aim of the Conference as the union of theoretical, experimental, and applied scientists "whose research together provides the possibility of unravelling the mysteries of basic physics" through the continued development of precision measurements and improve-

ment in the accuracy of the fundamental constants.

The Conference was composed of 15 highly specialized sessions, each dealing with a particular constant or measuring technique, usually beginning with a generalized invited talk on the subject followed by briefer summaries of related work. The subjects discussed included: frequency and time standards; length standards and the velocity of light; the Rydberg constant; electrical standards; the proton gyromagnetic ratio; atomic masses; the faraday; the proton magnetic moment; the Josephson effect; x rays; fine and hyperfine structure in simple atoms; lepton g-factor anomalies; and the gravitational constants.

Some of the important conclusions reached at the Conference include the following:

- Although much research is being carried out to develop new and im-



proved frequency standards, it is unlikely that the present cesium beam time standard will be replaced in the near future.

- The present  $^{86}\text{Kr}$  definition of length will no doubt be replaced in the not too distant future by a suitable stabilized laser. Or it may be practical to define the velocity of light as an exact number, thereby defining the length scale in terms of frequency and therefore time.

- Unless radical changes in approach are made, it is unlikely that the ampere or volt will be realized in absolute units to accuracies better than a few parts in  $10^6$ .

- A value for the gyromagnetic ratio of the proton accurate to a few parts in  $10^7$  is needed so that full advantage can be taken of the present values of  $2e/h$  (obtained from the ac Josephson effect) for the determination of the fine structure constant.

- The ac Josephson effect measurements of  $2e/h$  are now sufficiently accurate that the effect can be used to maintain standards of electromotive force.

- The availability of nearly perfect synthetic crystals such as silicon, and combined optical and x-ray interferometers, will soon make it unnecessary to maintain arbitrary x-ray scales. Accurate values of certain fundamental constants should also result.

- Low energy tests of quantum electrodynamics (QED) are well in hand. The theoretical values of the Lamb shift and fine structure splitting in hydrogen, deuterium, and ionized helium, the hyperfine splitting in hydrogen, muonium, and positronium, and the anomalous magnetic moments of the electron and muon, as calculated from QED theory using the value of the fine structure constant calculated from the Josephson effect measurements of  $2e/h$ , are in good agreement with the experimentally determined values.

Also presented at the Conference was a special general interest talk on Experimental Tests of General Relativity by R. H. Dicke of Princeton

University. He discussed the two general relativistic theories of gravitation, the tensor theory and the scalar-tensor theory, and the experiments that have been carried out to establish which of the theories is correct.

The Conference concluded with a panel discussion under the heading of Adjustments of the Fundamental Constants: Should Least Square Adjustments Be Abolished? Each of the six panelists gave a short presentation of his convictions on this and related subjects, followed by a question and answer period. The consensus was that such adjustments serve a very useful purpose.

The Conference was sponsored\* by the International Union of Pure and Applied Physics, the Committee on Data for Science and Technology of the International Council of Scientific Unions, the Committee on Fundamental Constants of the U.S. National Academy of Sciences and National Research Council, the National Bureau of Standards, and the International Bureau of Weights and Measures. The proceedings of the Conference will be published by NBS.

## NBS PRECISION MEASUREMENT GRANTS

At the 1970 International Conference on Precision Measurement and Fundamental Constants, Lewis M. Branscomb, Director of NBS, announced the establishment of an NBS grant program to encourage high quality work in the field of precision measurement. Grants of \$15 000 each are awarded to scientists whose research reveals a substantial interest in and talent for developing improved precision measuring techniques. Recipients of the first three grants are Professor James E. Faller of Wesleyan University, Professor Daniel A. Kleppner of the Massa-

\*Additional financial assistance was received from the following: General Motors Corp., Hewlett-Packard Co., International Business Machines Corp., Leeds & Northrup Co., National Conference of Standards Laboratories, North American Rockwell, Princeton Applied Research Corp., RCA/David Sarnoff Research Center, Scientific Apparatus Makers Assoc., and Texas Instruments Inc.

chusetts Institute of Technology, and Professor Hugh G. Robinson of Duke University.

NBS plans to make three new grants each year, and to extend a number of them for periods of up to three years. The grants are not intended to replace other sources of support, but to assist research workers in technically advancing their new ideas and novel techniques of precision measurement to a point where they can compete for other funds.

The first recipients have demonstrated the characteristics of sustained originality and excellence in precision measurements that NBS wishes to encourage. Brief descriptions of their proposed projects follow.

James E. Faller has made technological advances in several high-precision gravitational measurements including the Eötvös and Cavendish experiments. Significant increases in the sensitivity of the measurements are indicated by these experimental advances, some of which will be further explored under the NBS grant.

Daniel A. Kleppner proposes to carry out precision determinations of electronic and nuclear magnetic moments in the simplest atomic and molecular systems using a hydrogen maser operating in an applied magnetic field of 3500 G. This will contribute to a better understanding of the effects of binding on the magnetic moments of the electron and the proton, and in elucidating the theory of nuclear shielding in diatomic molecules. The work will also provide a new value for the magnetic moment of the proton in various reference solutions.

The proposal of Hugh G. Robinson concerns the precision determination of the ratio of "atomic" gyromagnetic ratios, or equivalently, the ratio of "atomic" magnetic moments. Specifically, a ratio of current interest is the  $g_J$ -factor of the bound electron in the hydrogen atom and that of the free electron,  $g_J(\text{H})/g_e(e^-)$ . The most recent determination of this

value has a precision of 1 part in  $10^6$ . He expects to achieve a precision of at least 1 part in  $10^7$  using the Duke University spectrometer, provided homogeneity and time stability are indeed the limiting factors for an optical pumping buffer-gas spin exchange experiment. Professor Robinson plans first to determine  $g_J(H)/g_S(e^-)$  in a buffer-gas environment by using spin exchange detection with optically pumped rubidium at 50 G magnetic field. This should allow an assessment of the severity of systematic errors encountered at low magnetic field, and in addition, allow a useful comparison with recent theoretical results.

NBS welcomes suggestions concerning potential grant recipients. Suggestions must be received by January 1 to be included in the next fiscal year's program, and must include a list of the nominee's publications, together with a short description of the proposed project. In awarding the grants, preference will be given to scientists 40 years old and younger.

All suggestions and comments should be addressed to Dr. Shirleigh Silverman, Office of Academic Liaison, Administration Building A1111,

National Bureau of Standards, Washington, D.C. 20234. Recommendations for the grants are made by a committee composed of members from NBS and the Joint Institute for Laboratory Astrophysics (JILA), under the current chairmanship of Dr. Peter Bender of JILA. The committee is aided by an advisory committee of distinguished scientists who have made major contributions to precision measurement. Current members of the advisory committee include: Professor Hans Dehmelt, University of Washington; Professor William Fairbank, Stanford University; Professor Vernon Hughes, Yale University; Professor Norman Ramsey, Harvard University; and Professor Joseph Weber, University of Maryland.

#### SCHEDULED NBS-SPONSORED CONFERENCES

*Each year NBS sponsors a number of conferences covering a broad range of topics in science and technology. The conferences listed below are either sponsored or cosponsored by NBS and will be held at the Bureau's Gaithersburg, Md., facility unless otherwise indicated. These conferences are open to all interested persons unless specifically noted. If no*

*other address is given, inquiries should be sent to the person indicated below in care of Special Activities Section, Room A600, Administration Building, National Bureau of Standards, Washington, D.C. 20234.*

**National Metric Study Conference.** Nov. 16-20. Contact: J. Odom (NBS Office of Invention and Innovation). To be held at Department of Commerce Auditorium, Washington, D.C.

**Symposium on the Application of Computers to Environmental Engineering Design.** Nov. 30-Dec. 2. Cosponsor: American Society of Heating, Refrigerating and Air Conditioning Engineers. Contact: R. Achenbach (NBS Building Research Division).

**Flow—Its Measurement and Control in Science and Industry.** May 10-14, 1971. Cosponsors: American Institute of Physics; American Society of Mechanical Engineers; Instrument Society of America. Contact: V. J. Giardina, Instrument Society of America, 400 Stanwix Street, Pittsburgh, Pa. 15222. To be held in Pittsburgh, Pa.

**Summer Symposium in Analytical Chemistry.** June 16-18, 1971. Cosponsor: American Chemical Society (Division of Analytical Chemistry). Contact: R. A. Durst (NBS Analytical Chemistry Division).

**Fifth Symposium on Temperature Measurement and Control in Science and Industry.** June 21-24, 1971. Cosponsors: American Institute of Physics; Instrument Society of America. Contact: H. H. Plumb (NBS Heat Division).

#### METRIC STUDY—Continued

views devoted to understanding metrification from the points of view of the engineering profession and manufacturing industry.

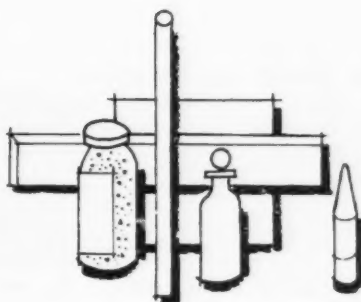
This Conference, cosponsored by the Engineering Foundation, is the first in a series of such meetings. Future meetings will take us beyond the problems of manufacturing industry into the service sector of the economy, the special problems of labor, consumers, education, and research. Through these conferences we hope to receive not only studies pre-

pared by trade associations, industrial representatives, and technical professionals, but also have an opportunity for oral presentation and an exchange of views among all those vitally concerned.

The National Bureau of Standards is obligated by law and committed by tradition to make an open-minded, quantitative evaluation of the questions we have been asked to answer. The job is clearly too broad to be done solely by technical people in our laboratories. Indeed the problems go far beyond technical questions and require that we deal with many sub-

jective issues. I doubt that an analytical result is even possible, but I hope we can eliminate the myths and limit the regions of uncertainty with both analysis and informed judgment. Perhaps we will not discover a national consensus on a subject about which most people are poorly informed. Perhaps the study may help people better to understand the implications of this complex question. This understanding can only be reached through the dedicated efforts of large numbers of citizens and organizations who are willing to work together to carry out this national study.

# STANDARD REFERENCE MATERIALS



*Standard Reference Materials are well characterized materials certified for chemical composition or for a particular physical or chemical property. These materials are disseminated by NBS to be used to calibrate and evaluate measuring instruments, methods, and systems or to produce scientific data that can be referred readily to a common base.<sup>1</sup>*

## PERMITTIVITY MEASUREMENT STANDARDS

Four polymer SRM's certified for permittivity measurements have recently been issued by the NBS Office of Standard Reference Materials. These standards were prepared from a fluorinated ethylene-propylene copolymer and are available in two diameters and two thicknesses, identified as follows:

- SRM 1516—38 mm diameter  
x 2.5 mm thick
- SRM 1517—38 mm diameter  
x 5 mm thick
- SRM 1518—51 mm diameter  
x 2.5 mm thick
- SRM 1519—51 mm diameter  
x 5 mm thick

Permittivity SRM's of glass and fused silica have been available from NBS in the past, but have been discontinued. These materials had a relatively high dielectric constant (relative permittivity) and were cer-

tified to  $\pm 0.3$  percent. The new standards are much more similar to the important insulating polymers. They are softer and have a lower dielectric constant than the glass standards. Their relative permittivities were determined by the three-terminal method using the two-fluid technique,<sup>2</sup> which yielded a pooled standard deviation of 0.0042 percent. As the measurement of sample thickness is a frequent source of inaccuracy in the determination of permittivity, these SRM's are also certified for their effective thickness. This value was also determined by the two-fluid technique, which yields more accurate values for thickness than micrometer measurements.

The relative permittivity values for the individual specimens of copolymers were found to differ from the mean of all specimens by a factor of ten greater than the standard deviation of a single specimen. Therefore, the specimens are individually identified and certified for relative permittivity, dissipation factor, and the average thickness of the central portion. The diameter of the central portion corresponding to the effective electrode diameter is also given for information.

The price of the new permittivity SRM's is \$193 per unit of one specimen.<sup>3</sup>

## TRACE ELEMENTS IN GLASS STANDARDS

A series of eight Trace Elements in Glass Standard Reference Materials is also available. This series of SRM's, certified for trace elements at four concentration levels, represents one of the most complex and comprehensive series of trace standards ever produced and issued.

These SRM's will be of value in establishing the accuracy of methods used in geology and geochemistry. Applications in quality control for the production of specialty glasses that incorporate trace elements are readily apparent. Instrumentalists employing such trace methods as emission spectroscopy, nuclear methods of analysis, mass spectroscopy, polarography, and spectrophotometry should also find the trace element series to be extremely useful.

In 1965, the Corning Glass Works of Corning, N.Y., began an extensive effort to provide NBS with the glasses that eventually became rod material from which this series was produced. Corning materials scientists prepared a large quantity of an extremely pure glass base material using very high-purity silica sand imported from South Africa and calcium oxide selected from a lot low in strontium content. From these materials, a base glass, nominally, 72 percent  $\text{SiO}_2$ , 12

percent CaO, 14 percent Na<sub>2</sub>O, and 2 percent Al<sub>2</sub>O<sub>3</sub>, was prepared and analyzed to ensure that trace elements were at a very low level.

Three 100-kilogram batches of this matrix were prepared, and doped with a glass containing 61 elements to give nominal concentrations (as the oxide) of 0.02 ppm, 1 ppm and 50 ppm for each of the 61 elements. A fourth 100-kilogram batch was prepared to contain 500 ppm of the 61 elements and is not a dilution of an original melt such as the other three. Starting with the base glass and progressing in concentration, each batch was remelted in a large platinum crucible and, after stirring twelve hours, was drawn into an approximately 1.2-cm diameter cane using a modified Czochralski technique.

The use of this technique by Corning not only minimized surface contamination, but also permitted an almost continuous drawing process for each batch. The drawing process for each batch took over 60 hours and gave 200 meters of cane. During the drawing, the cane was cut into two-meter lengths, which were serially numbered so that the entire history could be recorded. This practice proved extremely important for the homogeneity testing that followed at NBS. The canes numbered 30 through 90 were selected for distribution and certification.

At NBS the selected canes were cut into 10-cm rods and mounted for wafering. Using diamond saws and a wafering machine designed for this work, the samples were cut into 1-mm and 3-mm wafers. Considerable care, time, and expense were involved in this process to ensure that no cross-contamination could occur among the four concentration levels.

The overall homogeneity of the entire 200 meters at each elemental concentration has been tested and proven to be homogeneous within acceptable limits for those elements certified. However, work at NBS has shown that radial and crystallite segregation for some elements does

exist and therefore the entire wafer, not a fragment, must be used in analytical work.

The actual listing of the 61 elements added and the present status of the analytical certification are given in table 1.

All elements important to geologists, geochronologists and other earth scientists are present, for example, uranium, thorium, lead, strontium, potassium, and rubidium. Also present are those elements important in imparting to glasses such special properties as color.

During the melting process some elements were diminished in concentration by distillation, absorption, or both, while others were enhanced by impurities in the glass-making raw materials. For example, in the 500 ppm series the measured concentrations range from approximately 520 ppm for strontium to 62 ppm for thallium to approximately 25 ppm for gold.

The initial provisional certification of the elements in the four levels represents one of the most exacting and comprehensive analytical tasks ever performed at NBS. The principal analytical competences employed in the Analytical Chemistry Division for the measurement and certification were: isotope dilution mass spectrometry, which involved chemical tech-

niques of gravimetry, titrimetry, solvent extraction, and ion-exchange separations; polarography; flame emission and atomic absorption spectrometry; spectrophotometry; and nuclear methods of analysis, especially neutron activation techniques. During the course of this work, a nuclear track counting method for uranium and boron isotopes was made quantitative, and proved comparable in accuracy to isotopic dilution mass spectrometry at the lower concentrations—a truly remarkable development.

Well over 11 000-man hours of analytical time has been expended in the work thus far. Over the next few years, an equal or even greater expenditure of time will be required before most of the remaining elements are measured and certified.

Special recognition for support of this large undertaking is made to the staff of the Isotope Geology Branch of the Federal Center of the U.S. Geological Survey (USGS), Denver, Colo., who cooperated in the isotope dilution mass spectrometric determinations.

Ideally, certification at NBS is made only when the results of two or more different analytical methods agree (within limits agreed to beforehand) or, alternatively, when two or more results of an established

Table 1.

|             |             |              |             |
|-------------|-------------|--------------|-------------|
| *Antimony   | Fluorine    | Molybdenum   | Tantalum    |
| Arsenic     | *Gadolinium | *Neodymium   | Tellurium   |
| *Barium     | *Gallium    | *Nickel      | Terbium     |
| Beryllium   | Germanium   | Niobium      | **Thallium  |
| Bismuth     | *Gold       | Phosphorus   | ***Thorium  |
| *Boron      | Hafnium     | *Potassium   | Thulium     |
| Cadmium     | Holmium     | Praseodymium | Tin         |
| *Cerium     | Indium      | Rhenium      | ***Titanium |
| Cesium      | **Iron      | ***Rubidium  | Tungsten    |
| Chlorine    | *Lanthanum  | *Samarium    | ***Uranium  |
| Chromium    | ***Lead     | *Scandium    | Vanadium    |
| *Cobalt     | Lithium     | Selenium     | *Ytterbium  |
| *Copper     | Lutecium    | *Silver      | Yttrium     |
| *Dysprosium | Magnesium   | *Strontium   | *Zinc       |
| *Erbium     | **Manganese | Sulfur       | Zirconium   |
| *Europium   |             |              |             |

\*Indicates elements that have been studied but for which NBS has insufficient data to certify.

\*\*Element concentration certified at one or more levels.

\*\*\*Element concentration certified at all four levels.



method of known accuracy run independently by two or more scientists agree. The target precisions for homogeneity testing, and accuracies for assay, were set at: 2 percent or better for the 500 ppm materials, 5 percent or better for the 50 ppm materials, and state of the art for the 1 ppm and 0.02 ppm materials. Thus, the scientists engaged in this work were able to compare methods and to establish systematic biases for many techniques for a wide variety of analytical competences at NBS. The best example for this type of interplay is the data collected for the uranium concentrations at all four levels, which includes two separate laboratories (NBS and USGS) and the track counting at NBS. Even though the track counting showed that the uranium was not evenly distributed across the surface of the wafer (fission tracks used came from the top 15 micrometers of the wafer), and the isotope dilution analyses of the 50 ppm sample showed that the uranium concentration increased by 1 percent on rods 114 and beyond, the overall precision (homogeneity) and accuracy is more than adequate as can be seen from table 2. The indicated values are the averages from sample points between rods 30 and 90 and the indicated uncertainties are the total range of observed results between sample points.

Such intercomparison has operated successfully for many of the analytical methods and the results will be reported in detail in an NBS Special Publication to be issued in the near future. Purchasers of these SRM's will receive a copy of this publication as soon as it is available.

At this stage of provisional certification the indicated uncertainty for each elemental concentration given is the total range observed between sample points, and includes both analytical error and sample heterogeneity. The actual values certified are given on the Certificate of Analysis supplied with each SRM.

The SRM's are packaged as shown in table 3.

SRM's 610 through 617 sell for \$50

Table 3.

| SRM No.* | Wafer Thickness                                  | Concentration Range (ppm) |
|----------|--|---------------------------|
| 610----- | 3 mm-----  | 500                       |
| 611----- | 1 mm-----  | 500                       |
| 612----- | 3 mm-----  | 50                        |
| 613----- | 1 mm-----  | 50                        |
| 614----- | 3 mm-----  | 1                         |
| 615----- | 1 mm-----  | 1                         |
| 616----- | 3 mm-----  | 0.02                      |
| 617----- | 1 mm-----  | 0.02                      |
| 618      | Set contains one unit each of 610, 612, 614, 616 |                           |
| 619      | Set contains one unit each of 611, 613, 615, 617 |                           |

\* Each unit consists of 6 individual wafers.

a unit; <sup>3</sup> SRM's 618 and 619 each cost \$150.

#### NEW POLYMER STANDARDS

The Office of Standard Reference Materials has recently issued two polyethylene standard reference materials,<sup>1</sup> one linear (SRM 1475), the other branched (SRM 1476). These two whole polymer SRM's join two polystyrene standard reference materials, SRM 705 (narrow molecular weight distribution) and SRM 706 (broad molecular weight distribution), which have been available for several years for polymer characterization work.

The molecular weight distribution of SRM 1475, the linear polyethylene, has been determined with a gel permeation chromatograph calibrated with narrow molecular weight distribution fractions of linear polyethylene. The distribution in molecular weight so obtained constitutes part of the certification of SRM 1475. This standard may therefore be used to calibrate gel permeation chromatography instruments for linear polyethylene over a wide range of molecular weights—approximately

10<sup>3</sup> to 10<sup>6</sup>. This SRM is also certified for the limiting viscosity number (intrinsic viscosity) at 130 °C in three solvents: 1-chloronaphthalene, 1,2,4-trichlorobenzene, and decahydronaphthalene. The melt-flow rate and the density are also certified. SRM 1475 should be particularly useful for the calibration of instruments employed in molecular weight determination of polyolefins. It should also prove useful in research as a well characterized polymer of known molecular weight distribution.

SRM 1476, the branched polyethylene, is certified for limiting viscosity number at 130 °C using the same three solvents, for melt-flow rate (melt index), and for density. The SRM will be useful in such areas of polymer research as dilute solution studies, polymer rheology, and polymer crystal physics.

A series of reports describing investigations required for the certification of SRM 1475 will be published in the *Journal of Research of the National Bureau of Standards, Section A, Physics and Chemistry*.

Standard Reference Materials 1475 and 1476 are issued in units of 50 grams each. SRM 1475 costs \$100 per unit; SRM 1476 costs \$75 per unit.<sup>3</sup>

<sup>1</sup> For a complete list of Standard Reference Materials available from NBS, see Catalog of Standard Reference Materials, NBS Spec. Publ. 260 (July 1970 ed.) for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 75 cents; order by SD Catalog No. C13.10:260—1970 ed.

<sup>2</sup> Harris, W. P., and Scott, A. H., *Precise Measurement of Dielectric Constant by the Two-Fluid Technique*, 1952 Annual Report and the Conference on Electrical Insulation, National Academy of Sciences—National Research Council, Washington, D.C.

<sup>3</sup> These materials may be purchased for the prices indicated from the Office of Standard Reference Materials, Room B308, Chemistry Bldg., National Bureau of Standards, Washington, D.C. 20234.

Table 2.

|                         | 500         | 50           | 1             | 0.02            |
|-------------------------|-------------|--------------|---------------|-----------------|
| NBS-----                | 461.5 ± 1.1 | 37.39 ± 0.09 | 0.823 ± 0.002 | 0.0717 ± 0.0014 |
| USGS-----               | 461.3 ± 1.7 | 37.41 ± 0.21 | 0.828 ± 0.05  | 0.0729 ± 0.0017 |
| NBS track counting----- |             | 36.9 ± 1.8   | 0.827 ± 0.007 | 0.0725 ± 0.0015 |



# STANDARDS AND CALIBRATION

## STANDARD FREQUENCY AND TIME BROADCASTS

High-frequency radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast time signals on the Coordinated Universal Time (UTC) system as coordinated by the Bureau International de l'Heure (BIH), Paris, France. The NBS time scale, UTC(NBS), and the U.S. Naval Observatory time scale, UTC(USNO), are jointly coordinated to within  $\pm 5$  microseconds. The UTC pulses occur at intervals that are longer than one coordinate second by

300 parts in  $10^{10}$  during 1970, due to an offset in carrier frequency coordinated by BIH. To maintain the UTC scales in close agreement with the astronomers' time, UT2, phase adjustments are made at 0000 hours Greenwich Mean Time (GMT) on the first day of a month as announced by BIH. *There will be no adjustment made on December 1, 1970.*

The low-frequency radio station WWVB (Fort Collins, Colo.) broadcasts seconds pulses without offset to make available to users the standard of frequency so that absolute frequency comparisons may be made di-

rectly, following the Stepped Atomic Time (SAT) system. Step time adjustments of 200 ms are made at 0000 hours GMT on the first day of a month when necessary. BIH announces when such adjustments should be made in the scale to maintain the seconds pulses within about 100 ms of UT2. *There will be no adjustment made on December 1, 1970.*

NBS obtains daily UT2 information from forecasts of extrapolated UT2 clock readings provided by the U.S. Naval Observatory with whom NBS maintains close cooperation.

## PUBLICATIONS of the National Bureau of Standards\*

### PERIODICALS

*Technical News Bulletin*, Annual Subscription: Domestic, \$3; foreign, \$4. Single copy, 30 cents. Available on a 1-, 2-, or 3-year subscription basis. SD Catalog No. C13.13:54.

*Journal of Research of the National Bureau of Standards*

*Section A. Physics and Chemistry*. Issued six times a year. Annual subscription: Domestic, \$9.50; foreign, \$11.75. Single copy price varies. SD Catalog No. C13.22/sec.A:74.

*Section B. Mathematical Sciences*. Issued quarterly. Annual subscription: Domestic, \$5; foreign, \$6.25. Single copy, \$1.25. SD Catalog No. C13.22/sec.B:74.

*Section C. Engineering and Instrumentation*. Issued quarterly. Annual subscription: Domestic, \$5; foreign, \$6.25. Single copy, \$1.25. SD Catalog No. C13.22/sec.C:74.

### CURRENT ISSUES OF THE JOURNAL OF RESEARCH

*J. Res. Nat. Bur. Stand. (U.S.)*, **74A** (Phys. and Chem.), No. 6 (November-December 1970), SD Catalog No. C13.22/sec.A:74/6.

Corliss, C. H., A review of oscillator strengths for lines of Cu I.

Hamer, W. J., and Wu, Y. C., The activity

coefficients of hydrofluoric acid in water from 0 to 35 °C.

King, R. C., and Armstrong, G. T., Fluorine flame calorimetry III. The heat of formation of chlorine trifluoride at 298.15 K.

Prydz, R., and Straty, G. C., PVT measurements, virial coefficients, and Joule-Thomson inversion curve of fluorine.

Radford, H. E., and Kurtz, C. V., Stark effect and hyperfine structure of HCN measured with an electric resonance maser spectrometer.

Shenstone, A. G., The second spectrum of nickel (Ni II).

### OTHER NBS PUBLICATIONS

Blaine, R. L., Tomes, L. A., Exploratory studies of early strength development in portland cement pastes and mortars, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 28, 14 pages (July 1970) 25 cents, SD Catalog No. C13.29/2:28.

Bryson, J. O., Carpenter, E. F., Flexural behavior of prestressed concrete composite Tee-beams, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 31, 14 pages (July 1970) 25 cents, SD Catalog No. C13.29/2:31.

Catalog of standard reference materials, Nat. Bur. Stand. (U.S.), Spec. Publ. 260-1970 ed., 84 pages (July 1970) 75 cents, SD Catalog No. C13.10:260-1970 ed.

Heinrich, K. F. J., Present state of the classical theory of quantitative electron

probe microanalysis, Nat. Bur. Stand. (U.S.), Tech. Note 521, 17 pages (Aug. 1970) 30 cents, SD Catalog No. C13.46:521.

LaFleur, P. D., ed., Activation analysis section: Summary of activities July 1968 to June 1969, Nat. Bur. Stand. (U.S.) Tech. Note 508, 147 pages (July 1970) \$1.25, SD Catalog No. C13.46:508.

Locke, J. W., Penn, R., Rick, J., Buntin, E., Hare, G., Compilation and use of criminal court data in relation to pre-trial release of defendants: Pilot study, Nat. Bur. Stand. (U.S.), Tech. Note 535, 242 pages (Aug. 1970) \$1.75, SD Catalog No. C13.46:535.

Sher, A. H., Nomographs for use in the fabrication and testing of Ge(Li) detectors, Nat. Bur. Stand. (U.S.), Tech. Note 537, 18 pages (Aug. 1970) 30 cents, SD Catalog No. C13.46:537.

Stevenson, D. R., Technical Standards Coordinator, Melamine dinnerware (alpha-cellulose-filled) for household use, Nat. Bur. Stand. (U.S.), Prod. Stand. 24-70, 9 pages (Aug. 1970) 10 cents, SD Catalog No. C13.20/2:24-70. Supersedes Commercial Standard CS 210-57.

Stevenson, D. R., Technical Standards Coordinator, Heavy-duty alpha-cellulose-filled melamine tableware, Nat. Bur. Stand. (U.S.), Prod. Stand. 25-70, 8 pages (Aug. 1970) 10 cents, SD Catalog No. C13.20/2:25-70. Supersedes Commercial Standard CS 173-50.

- Wegstein, J. H., Automated fingerprint identification, Nat. Bur. Stand. (U.S.), Tech. Note 538, 33 pages (Aug. 1970) 40 cents, SD Catalog No. C13.46:538.
- White, H. J., Jr., States and outlying areas of the United States, Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS Pub) 5-1, 4 pages (1970) 20 cents, SD Catalog No. C13.52:5-1. Supersedes FIPS PUB 5, Nov. 1, 1968.
- White, H. J., Jr., Counties and county equivalents of the states of the United States, Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS Pub) 6-1, 34 pages (1970) 45 cents, SD Catalog No. C13.52:6-1. Supersedes FIPS PUB 6, Nov. 1, 1968.

## PUBLICATIONS IN OTHER JOURNALS

*This column lists all publications by the NBS staff, as soon after issuance as practical. For completeness, earlier references not previously reported may be included from time to time.*

- Arp, V., Heat transport through helium II, *Cryogenics* 10, No. 2, 96-105 (Apr. 1970).
- Brauer, G. M., Pyrolysis-gas chromatographic techniques for polymer identification, Chapter 2 in *Techniques and Methods of Polymer Evaluations*, P. Slade, Ed., II, 41-104 (Marcel Dekker Publ., New York, N.Y., 1970).
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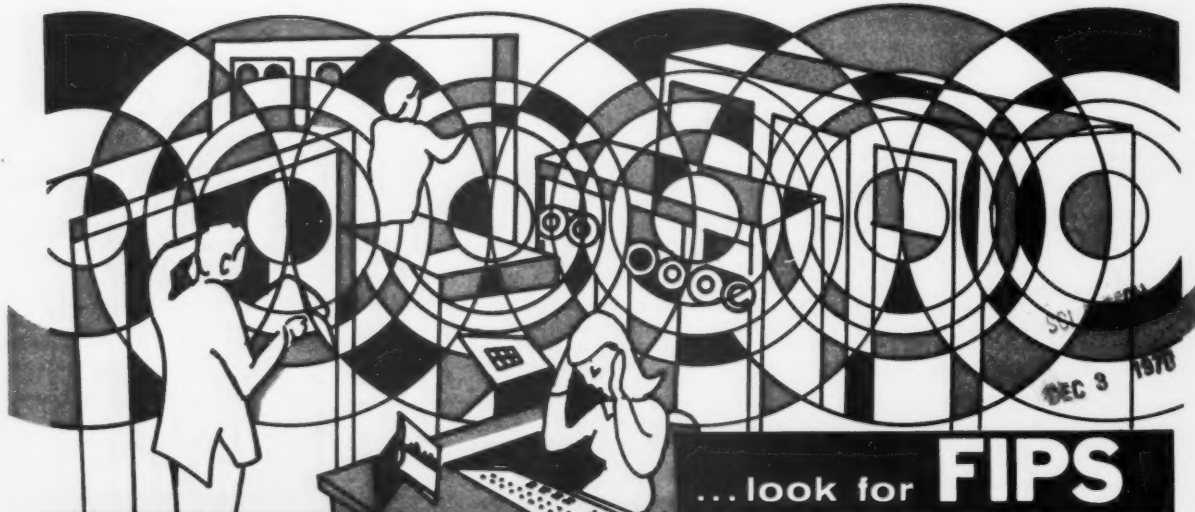
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